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TO; Miss Winnie M. Morgan, Technical Reports Officer,
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FROM: H. Gaffron, Principal Investigator
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Carotene Induced Respiration

A great puzzle to photobiologists is the specific effect of blue light in photosynthetic organisms. The number of papers reporting on such a blue light effect is rapidly growing.

Dr. Wolfgang Kowallik from Göttingen had just confirmed that this effect truly exists in photosynthetic algae when he joined my laboratory. In blue instead of red light the algae contain more protein. If it is a carotenoid that absorbs the light then it must be a carotene or xanthophyll which is not in energetic transfer exchange with chlorophyll, since it could not then produce any other than a photosynthetic effect which chlorophyll normally does. If it were the second singlet state of chlorophyll that catches the blue light it would be the first time that one has seen a dye so bound to some neighboring molecule that the heat loss in the transition to the first singlet can be successfully side-stepped. But if we ask what other molecule this energy acceptor might be, it must be one with which a photophysical instead of a photochemical contact is easiest. And again because of so completely overlapping absorption we have to think of a flavin or carotene. If this photophysical contact with the 2nd singlet is too hair-raising an assumption, we can always return to the special light absorbing carotene which makes use of the absorbed energy in a hitherto unknown way.

The trouble is only that just as in photosynthesis the light absorption takes place in a fraction of a second, but the result becomes testable only after a lag that is many thousand times longer. In contrast to vision, where a split second illumination of the retina suffices to become aware of a complex picture, this blue light effect is not connected with an amplifier system of such tremendous efficiency. The blue light effect looks rather like the result of a minor but steady metabolic change. First Dr. Kowallik succeeded in eliminating the photosynthetic process as such as an accomplice. This can be done by poisoning photosynthesis with DCMU while leaving respiration intact - or by using a mutant alga which is unable to evolve oxygen but still capable of photoreduction and therefore of photophosphorylation. The blue light effect - extra protein formation - is still there. Now Dr. Kowallik proceeded to watch the gas exchange of poisoned or mutated algae during the many hours that were necessary to produce testable yields of protein. And this procedure was successful. The glucose grown algae are washed and suspended in plain buffer, exposed to blue light or red light or darkness. A difference is there, probably from the beginning but initially hard to see. After eight to ten hours the respiration in the blue light exposed algae has remained practically unchanged, while the respiration in red light or darkness has declined and is now 20 to 50 per cent below that in the blue. Blue light then has the capacity to maintain a respiration that gives a higher level of synthetic activity in the cell, the end result of which is a relatively larger content of protein.

This is the first time that a clear-cut effect of light on respiration has been seen where the effect is not an indirect one via photosynthesis and its products. Obviously a great number of novel experiments suggest themselves. The most interesting one would be to find a Rabinowitch effect - a utilization of the second singlet state energy - but this seems improbable indeed.

Personnel supported by this grant

Dr. Wolfgang Kowallik, Research Associate, full time.

Mrs. Patricia Hayward, Research Assistant, half time.

Professor Hans Gaffron, Principal Investigator, one-twelfth time.

Mr. Walter Herold, Research Technician, one-sixth time.